

Unmanned Aerial Systems:
The Future of Marine Fixed Wing Aviation

Submitted by Captain Angela R. Hooper
to
Major R. Tatum, CG 14
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As the most advanced military in the world, the United States has maintained a reputation for combining advanced technology with sound tactics. At the forefront of today's technological advances is the development of unmanned aerial systems (UAS). Enhancements in UASs have transformed the current battle space with innovative tactics, techniques and procedures. These developments are now providing combatant commanders support capabilities such as persistent intelligence, surveillance, reconnaissance, and timely and accurate direct and indirect fires, consequently eliminating the inherent risks of launching manned aircraft into harm's way. Because of the survivability, reduced costs, and constantly improving capabilities of unmanned aircraft systems, the Marine Corps should begin transitioning from manned fighter attack aircraft to all unmanned aerial systems.

HISTORY

The Department of Defense defines unmanned aircraft as a powered aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide vehicle lift, can fly autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or non lethal payload.¹ UASs are not a new concept and have enjoyed a long history in military aviation extending back to the first World War. During the Korean War, the United States employed UASs for reconnaissance missions determined too

hazardous for manned aircraft and then as highly classified "special purpose aircraft" during the conflict in Southeast Asia. These missions, operating at a fraction of the cost and risk of manned aircraft, began to introduce the potential utility of UASs.² Shortly after, the Air Force began investigating the potential effectiveness of expanding the UASs role beyond reconnaissance, specifically in air defense suppression and strike missions; however, operational assessment never took place. Interest in UASs dwindled through the 1970s and 1980s and did not reemerge until their employment during Operations Desert Shield and Desert Storm. UASs appeared as a critical source of intelligence at the tactical level with most of the U.S.'s manned tactical reconnaissance assets committed. The United Nations and NATO also brought international attention to the advantage of military UASs with their extensive use during proceedings in the former Yugoslavia. According to *Jane's Unmanned Aerial Vehicles and Targets*, at least fourteen countries are using or developing over 76 different types of surveillance, target acquisition, electronic warfare, and expendable UASs.³ Today, the military role of UAS is growing at unprecedented rates. As of October 2006, coalition UASs, exclusive of hand-launched systems, had flown almost 400,000 flight hours in support of Operations Enduring Freedom and Iraqi Freedom.⁴ The United States Marine Corps can use UASs to perform all six functions of Marine

Aviation: assault support, offensive air support, anti-air warfare, electronic warfare, control of aircraft and missiles, and reconnaissance.⁵ The possibilities for UASs continue to expand as today's battlefield continues to transform.

SURVIVABILITY

Because of the survivability of UASs, the USMC should begin transitioning from manned fighter attack aircraft to all unmanned aircraft systems. Unmanned aircraft systems are being considered for an increasingly broad range of missions, resulting in a growth of platform types and quantities, mission roles and equipment, and expanding operational environments. System costs and/or mission criticality has made UAS survivability a crucial system characteristic vice their manned counterpart in which survivability is directly correlated to crew survivability. Whenever the US military sends a manned aircraft into combat, they are putting at risk a pilot and aircraft that are dear to American citizen's conscience and the government wallet. The use of UAS not only denies enemy high value targets and potential captives, but it also caters to American moral principles by eliminating unnecessary loss of life.

Mission endurance also provides a strong argument in favor of UAS survivability. Certain combat missions executed by manned aircraft are restricted due to human capability

limitations. For example, surveillance and reconnaissance missions equipped with inhuman endurance provide persistent observation and decreased sortie requirements. A manned fighter will seldom be able to stay on station for longer than an hour whereas a UAS could conceivably stay on station for days or weeks, depending on the given state of technology.⁶ The US Air Force is presently promoting research that is predicted to produce an inflight UAS refueling capability by 2009.

Additionally, fewer flight hours are lost due to reduced time otherwise needed for transit periods to and from airfields. In the long run, fewer take offs and landings translate to less vulnerability to close range enemy fire, essentially reducing mishap rates during the most critical phases of flight.

UAS possess several other advantageous survivability characteristics. Due to the size, heat, and sound signatures of UASs, stealth capability is significantly increased. Also, UASs possess improved adverse weather capability. Continuously improving technologies allow for less interference from non-kinetic fires. Where human capabilities have culminated, UAS potential continues to improve. Man flies today because of the technological inadequacies of yesterday.

REDUCED COSTS

Because of the reduced costs, the USMC should begin transitioning from manned fighter attack aircraft to all

unmanned aircraft systems. The Marine Corps has always prided itself in taking the limited funding it receives from the Department of Defense and doing "more with less." Marine Corps aviation has been no stranger to these same budget constraints, and it is likely that fiscal limitations will become more restrictive in the future. Unmanned aerial system's offer several financial advantages to the Marine Corps, both short and long term. Most notably, seventy percent of non-combat aircraft losses are attributed to human error, and a large percentage of the remaining losses have human error as a contributing factor.⁷ Elimination of the human pilot can considerably reduce the monetary consequence of man-made mistakes.

UASs also offer an added advantage in that the need to conduct training and proficiency sorties with unmanned aircraft through physical flights can be reduced, if not eliminated with high fidelity simulators. The fewer physical flights will ultimately result in fewer maintenance hours, fewer aircraft losses, and lowered attrition expenditures. Further, UAS allow for reduced fuel requirements and offer unlimited potential to utilize alternative fuel sources to gasoline.

IMPROVING CAPABILITIES OF UNMANNED AIRCRAFT SYSTEMS

Because of the constantly improving capabilities of unmanned aircraft systems, the USMC should begin transitioning from manned fighter attack aircraft to all unmanned systems. Many

defense analysts argue that the nature of warfare and the way the United States will fight future wars are undergoing a fundamental transformation. Where the human war fighter's limitations and capabilities are nearing its climax, technological advances provide unlimited potential and possibilities. Among those technological aspirations is the development of UAS autonomy. The ultimate goal of autonomy is for system software to be capable of and entrusted to make substantial real-time decisions without human involvement or supervision. Simply put, the quest for autonomy is to teach machines to be "smart" and act more like humans. To some extent, the final objective in the development of autonomy technology is to replace the human pilot. Human equivalence in speed and capacity is projected to be achieved by 2015, nearly 15 years earlier than initial estimates.⁸

Additionally, the use of UASs could aid in the effective delivery of munitions with their ability to more accurately process weather conditions. For example, a tube-launched, optically tracked, wire-guided, anti-armor round - better known as TOW - can more accurately affect targets through its ability to determine wind variant and other atmospheric conditions. Smaller UAS size will equate to smaller weapons, resulting in the necessity for smarter munitions. Smarter munitions will ultimately reduce collateral damage and the loss of life on non-

combatants. Current manned platforms deliver munitions that often leave shatter infrastructures in states the US government will later be expected to rebuild.

COUNTERARGUMENT

One of the most widespread concerns of UASs is the absence of a human element. Completely autonomous weapon systems are problematic since it is difficult to assign accountability for munitions effects to a specific person. For these reasons, current designs still incorporate an element of human control—meaning that a ground controller must authorize weapons release. Despite the implication of the name, unmanned systems still include a human element. Even in highly autonomous systems, humans are required to provide high-level objectives, set rules of engagement, supply operational constraints, and support launch-and-recovery operations.

Humans need to interpret sensor information, monitor systems, diagnose problems, coordinate mission timelines, manage consumables and other resources, authorize the use of weapons or other mission activities, and maintain system components. Although a person is no longer co-located in mission execution with the dynamic components of the unmanned system represents a modification rather than an elimination of the role of humans. Regardless of the C2 hardware and software utilized, one thing seems clear: there must be a human operator who is highly skilled

and thoroughly indoctrinated in aviation procedures, but remains a part of the ground combat element.⁹ Pilotless aircraft provide combatant commanders the ability of a single platform to locate, identify, and attack a target with greatly reduced response time compared to today's process of issuing a nine line brief, ensuring the controller and the aircraft crew are indeed focused on the same target, and ensuring that "clearance to drop" is obtained from whatever level is dictated.

Another controversial competency shortfall is the lack of search and avoid capability (S&A). The FAA does not provide a quantifiable definition of S&A. However, the intent of S&A is for pilots to use their sensors and other tools to find and maintain situational awareness of other traffic and to yield the right of way when there is a traffic conflict. The challenge of S&A is a capability constraint; therefore, focus should be directed towards the intent that is avoiding mid-air collisions. UASs software design must be capable of detecting traffic that may be a conflict, evaluating their flight path, determining the right of way, and, as required, maneuvering well clear of the conflicting traffic. S&A capabilities are a current limitation that will be addressed through customary technological development.

The MQ-1 Predator has already employed weapons in direct support of ground troops, although not doctrinally executed or

described as close air support. Additionally, and the U.S. Marine Corps has used its UASs to execute artillery calls for fire and to coordinate air strikes on targets it has detected. Given the current pace of technological advance coupled with implementation of current assets, future unmanned systems will be capable of successfully completing these operations and much more.¹⁰ Countless UASs possess the ability to fly to a given coordinate. It does not present a huge technical challenge to hang a GPS weapon on an unmanned vehicle, provide target coordinates to the weapon while airborne, then fly it to the appropriate delivery envelope and release it. During fighting in Fallujah, ordnance was dropped as close as 100 meters from Marine Corps units; normally, heavy bombs are employed no closer than 1,000 meters from friendly positions.¹¹

CONCLUSION

The United States must ensure it is competitive with other countries who are utilizing this same technology and are advancing well beyond its current capabilities. Countries that can exploit emerging technologies and synergize the same with innovative organizational adaptation could achieve greater levels of military effectiveness. Historically, leading countries, including the United States, have enjoyed adequate time to implement military technologies that developed in peace time. Such a luxury is now precluded by the sheer pace of

technological transformation and the typical change in warfare itself. In the coming years, political leaders, military establishments, civil services and defense research scientists will need to stay alert to emerging technologies so that technological asymmetry can be sustained against competitors and adversaries.¹²

Unmanned aircraft systems offer considerable advantages in terms of survivability, reduced costs and constantly improving technologies. Where human capabilities have culminated, UAS development presents limitless opportunity for progression. The Marine Corps should remain in control of its own destiny and maintain its legacy of innovation in combat capabilities and doctrine. Consequently, it must move to the forefront of UAS development and employment; doing so is both fiscally and operationally smart.

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BIBLIOGRAPHY

Borin, Elliot. *Better Bombing Through Technology*. March 2004, <http://www.wired.com/science/discoveries/news>.

Bruno, Michael. "ares' Top War Tech: Precision Munitions", *Aviation Week*. May 31, 2007.

Carmichael, Col Bruce W., DeVine Maj Troy E., Kaufman, Maj Robert J., Pence, Maj Patrick E., and Wilcox, Maj Richard S. "Strikestar 2025," August 1996.

Castellaw, LTGEN John G. Statement by Deputy Commandant for Aviation before the tactical air and land forces subcommittee of the house armed services committee on FY07 Naval UAS and UCAS Programs, April 6, 2006.

Chapman, Col Robert E. II, USAF, "Unmanned Combat Aerial Vehicles, Dawn of a New Age?" *Aerospace Power Journal*, Summer 2002.

Defense Update, International Online Defense Magazine. <http://www.defense-update.com/products/s/sdb.htm>

Dixit, J. N. "Challenges from the Geo-Strategic Environment", Proceedings of a Seminar on "Command and Staff Challenges in the 21st Century" held at Defence Services Staff College, April 14-15, 1998.

Erwin, Sandra I. "Navy Aims to Curtail Aviation Mishaps Caused by Human Error". *National Defense Magazine*. October 2000.

Herbert, Adam, "New Horizons for Combat UAVs", *Air Force Magazine*, December 2003, Vol. 86, No. 12.

Jane's Unmanned Aerial Vehicles and Targets. <http://juav.janes.com/public/juav/index.shtm>

Joint Publication 1-02. Department of Defense Dictionary of Military and Associated Terms.

Klein, LCDR John J. The Problematic Nexus: Where Unmanned Combat Air Vehicles and the Law of Armed Conflict Meet; John J. Klein, LCDR USN ; *Air and Space Power Journal*; 2004

Kreisher, Otto. *Navy League of the United States; In Demand*, <http://www.navyleague.org>.

Miles, Donna. "Unmanned Aircraft Gain Starring Role in Terror War." *American Forces Press Service*, November 9, 2004.

Office of Secretary of Defense, *Unmanned Aircraft Systems Roadmap 2005-2030*, July 2005

Peck, Michael. "Dysfunctional Interagency Coordination Hampers Domestic Deployment of Drones". *National Defense Magazine*. May 2006.

Powers, E.W. Unmanned Combat Air Vehicles (UCAV): The Future of MAGTF Strike and Close Air Support. Potomac Institute for Policy Studies. November 2007.

Stout, LtCol Jay, USMC (Ret), "Close Air Support Using Armed UAVs?" *Proceedings*, July 2005.

Schachtman, Noah, *How Israel's Drones Fought the War*, <http://www.noahsharhtman.com/archives/002722.html>.

Wikipedia, History of Unmanned Vehicles.www.wikipedia.org.

Williams, Kevin W. An Assessment of Pilot Control Interfaces for Unmanned Aircraft. Federal Aviation Administration, April 2007.

¹ Joint Publication 1-02: Ballistic or semi ballistic vehicles, cruise missiles, and artillery projectiles are not considered unmanned aerial vehicles.

² Wikipedia, The History of Unmanned Aerial Vehicles.

³ Jane's Unmanned Aerial Vehicles and Targets. <http://>

⁴ Office of Secretary of Defense, *Unmanned Aircraft Systems Roadmap 2005-2030*, July 2005.

⁵ E. W. Powers, *Unmanned Combat Air Vehicles (UCAV): The Future of MAGTF Strike and Close Air Support*. Potomac Institute for Policy Studies. November 2007.

⁶ E. W. Powers. *Unmanned Combat Air Vehicles (UCAV): The Future of MAGTF Strike and Close Air Support*. Potomac Institute for Policy Studies. November 2007.

⁷ Sandra I. Erwin. "Navy Aims to Curtail Aviation Mishaps Caused by Human Error". *National Defense Magazine*. October 2000.

⁸ Office of Secretary of Defense, *Unmanned Aircraft Systems Roadmap 2005-2030*, July 2005.

⁹ E.W. Powers. *Unmanned Combat Air Vehicles (UCAV): The Future of MAGTF Strike and Close Air Support*. Potomac Institute for Policy Studies. November 2007.

¹⁰ Unmanned aerial vehicles (UAVs) like the US RQ-1 Predator are increasingly being armed and used for missions other than pure reconnaissance. It was, in fact, a Predator that on December 23, 2002 made history over Iraq by becoming the first UAV to engage in a dogfight with a manned fighter: an Iraqi MiG-25 contesting Iraq's Southern No-Fly Zone. In what has been described as a 'sharp engagement' in which both sides opened fire, the Predator's Stinger missiles were outranged by the Iraqi Foxbat's R-40RDs and the Predator was downed.

¹¹ E. W. Powers. *Unmanned Combat Air Vehicles (UCAV): The Future of MAGTF Strike and Close Air Support*. Potomac Institute for Policy Studies. November 2007.

¹² There is considerable interest in UCAVs globally. Currently, some 32 nations are developing or manufacturing more than 250 models of UAS and 41 countries operate some 80 types of UAS, primarily for reconnaissance.